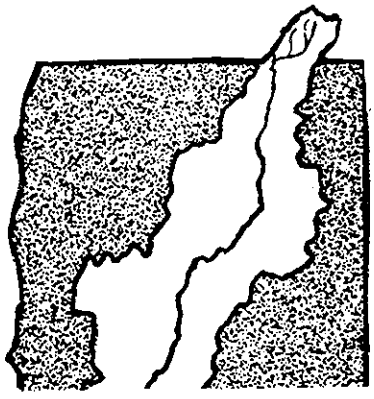
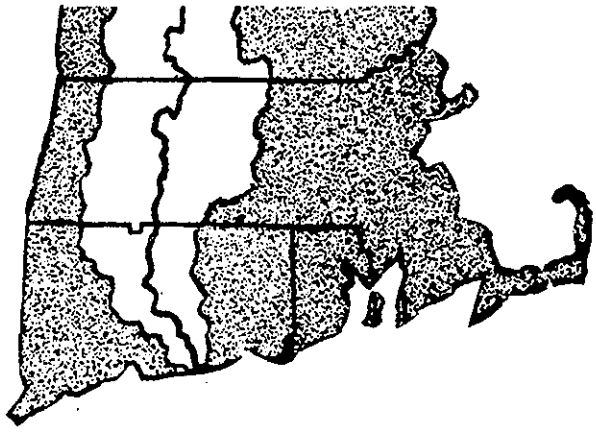
COMPREHENSIVE WATER AND RELATED LAND RESOURCES INVESTIGATION



CONNECTICUT RIVER BASIN



PLAN OF SURVEY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

APRIL 1966

1. INTRODUCTION

The plan of survey sets out the procedures to be followed in developing a comprehensive plan for the Connecticut River Basin to provide the best use, or combination of uses, of water and related land resources to meet all foreseeable short and long-term needs. It is to be used as a management tool to assist in orientation, direction, and coordination, as well as to show the interrelationships and missions between the participants within the study. It is intended that it be flexible, undergoing periodic modification as required.

2 AUTHORITY FOR STUDY

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE. ADOPTED May 11, 1962:

"That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 12, 1902, be, and is hereby, requested to review the reports on the Connecticut River, Massachusetts, New Hampshire, Vermont, and Connecticut, published as House Document Numbered 455, Seventy-fifth Congress, second session, and other reports, with a view to determining the advisability of modifying the existing project at the present time, with particular reference to developing a comprehensive plan of improvement for the basin in the interest of flood control, navigation

hydroelectric power development, water supply, and other purposes, coordinated with related land resources."

3. OBJECTIVE OF INVESTIGATION

The basic objective of the Connecticut River Basin Comprehensive survey (a type II study) is the formulation of a plan of development which will serve as a guide to the best use, or combination of uses, of water and related land resources of the basin to meet foreseeable short and long-term needs. To this end consideration will be given to meeting present and future requirements for water supply, flood control, navigation, water quality control, hydroelectric power, recreation, fish and wildlife, and other purposes requiring development of water and related land resources. The investigations will emphasize formulation of a detailed plan to meet the water needs through 1980 and indicate potentials to meet the needs through 2020. The plan will include components to supplement existing and currently planned developments so as to meet the 1980 water needs of the basin and those of other areas likely to be satisfied from the basin. Measures capable of meeting longer term requirements will be incorporated in the plan.

4. BASIN DESCRIPTION

The Connecticut River Basin, an area of 11,136 square miles extending 280 miles from Canada to Long Island Sound, is embraced

by four states. Thirteen percent is in Connecticut, 24 percent in Massachusetts, 28 percent in New Hampshire, and 35 percent in Vermont. Excluded from this study are 114 square miles in Canada. The main river separates New Hampshire and Vermont (west bank) and cuts through the west-central sections of Massachusetts, where the basin reaches its maximum width of about 60 miles, and Connecticut. With its system of tributaries, the Connecticut River drains 41 percent of Vermont, 33 percent of Massachusetts and New Hampshire, and 29 percent of Connecticut. The sixteen major tributary basins range in size from 150 to over 700 square miles.

Hilly uplands prevail throughout much of the basin. Important ranges of hills and mountains are the Berkshire and Green Mountains forming the western margins of its middle and lower portions and the White Mountains in its upper portion. Extensive lowlands are confined to the flood plains of its lower portion in Massachusetts and Connecticut.

Precipitation as both rain and snow averages about 43 inches of water within a range of 35 to 60 inches. Runoff, reflecting large snowmelt in the spring, represents a little more than 50 percent of annual precipitation. Average flow of the Connecticut River in the lower basin is 18,000 cfs. Three tributary streams have mean flow of 1,000 cfs or more. These are the White River with

confluence near the upper limit of the middle basin, and the Chicopee and Farmington with confluence in the lower basin. Frost-free periods range from 180 days near Long Island Sound to 100 days in the upper basin.

Basin population in 1960 was 1,680,000 or about 20 percent of total population in the four states. Major metropolitan areas, Springfield and Hartford, in the lower basin account for 60 percent of basin population. Total basin population is 72 percent urban. Towns with 10,000 or more people are found outside the metropolitan areas in the lower basin and to a more limited extent in its middle portion, but they are absent in the upper basin. Population in 1960 for the portion of each state in the Connecticut River Basin and population projections are given below:

CONNECTICUT RIVER BASIN POPULATION

	1960	1980	2000	2020
Population (1000) Total	1,680	2,280	3,100	4,140
New Hampshire	116	158	228	316
Vermont	112	145	192	248
Massachusetts	662	847	1,130	1,520
Connecticut	790	1,130	1,550	2,060

5. CURRENT STATUS OF WATER AND RELATED LAND RESOURCES DEVELOPMENT IN THE BASIN

Water and related land resources developments of substantial proportions have been constructed in the Connecticut River Basin by public and private interests. These include significant investments in:

a. Flood control storage reservoirs in the upper reaches and local protection works in the lower basin;

b. Hydro-electric power plants and storage reservoir sites in conjunction therewith and nuclear power plants;

c. Numerous surface water supply-impoundments serving municipalities and industry;

d. Sewage treatment facilities at many communities with an active program of expansion of existing plants and addition of new plants;

e. Navigation channels and recreational harbors between Long Island Sound and Hartford. Local improvement(s) for recreational boating are also available in the stream reaches of the Connecticut River and on the numerous lakes;

f. Recreation facilities at many lakes and ponds throughout the basin; and

g. Purchase of access points and fishing rights along streams and establishment of waterfowl and other fish and game habitat areas.

6. WATER RELATED LAND RESOURCES NEED AND PROBLEMS

The Connecticut River Basin is rich in natural resources including water. Although it possesses a substantial inventory of existing water resource projects, it is, and will be, experiencing shortages in resource areas that could be alleviated through proper management and efficient development of natural resources. Like so many similar areas of the country, an expanding population and industrial growth reflect a growing use of our rivers and other resources with its attendant demands and needs for water resource development and conservation. Satisfying needs and eliminating problems call for action in at least the following resource areas: *

a. Increased flood control storage to augment the degree of protection provided by existing reservoirs and local protection projects, and additional local protection improvements particularly in those where recent growth has encroached on flood plains.

b. Increased land management and watershed protection and flood control prevention measures to conserve the agricultural and forest resources and to control erosion and sediment production. *

c. Increased hydroelectric power development to include pumped storage facilities.

d. Increased navigation facilities particularly for recreational boating.

e. Continued conservation and, in some instances, restoration of fish and wildlife resources.

f. Increased development of water-based public recreation sites.

g. Increased demands for water supplies for municipal and industrial purposes and other uses which have experience and will continue to experience substantial increases.

h. Improvement of water quality in some areas and alleviation of future deterioration which is likely to occur even assuming conventional treatment of wastes, is expected to require large volumes of dilution water.

i. Diversions - in addition to demands arising within the basin it is anticipated that major urban areas outside the basin may require substantial additional diversion of water from the watershed.

j. Drainage problems exist in varying degrees throughout the basin. Both tile and open ditch drainage are needed in many areas for maximum production of agricultural products. Consideration will also be given to improvement of major drainage facilities in certain urban areas.

k. Although water for irrigation is not in heavy demand at present, some additional need for water irrigation is expected to develop in the basin.

7. IMPROVEMENTS DESIRED

In order to determine the resources improvements desired within the Connecticut River Basin, four public hearings have been held in the Basin. Sites of public hearings were Claremont, N.H., St. Johnsbury, Vt., Westfield, Mass., and Berlin, Conn. In addition to representatives of State, local, and Federal agencies a goodly number of interested citizens attended and expressed their views.

A wide range of areas of interest and desires for improvements were expressed. They include the following:

a. Importance of conservation of forest resource.

b. Improvements concerning pollution abatement.

c. Improvement of river banks and purchase of existing islands to enhance beauty of river.

d. Streambank erosion control.

e. Protection for ice flow flooding.

f. Flood protection of communities in the tributaries and main river.

g. Additional recreation opportunities on the river at existing water bodies and at impoundments to be developed.

h. Need for water supply, domestic and industrial.

i. Hydroelectric power development including pumped storage and cooling water for thermal power plants.

j. Preservation and improvement of fishery resource.

k. Improvement of low flow conditions and regulation of existing storage facilities.

l. Preservation of the river's scenic beauty.

m. Restoration of river waters to highest quality consistent with prudent development.

n. Consideration of the adverse effect that major diversion and consumptive uses have on lower riparian owners and users.

o. Use of river for bathing, fishing, hunting, aquatic sports, picnicking.

p. Recreational navigation.

q. Consideration of effect of thermal power plants on water temperatures and ecology.

r. Preservation of "open space".

s. The need for use of the river water for water supply.

t. Dredging of the Connecticut River.

u. Use of flood plain at Wethersfield, Connecticut.

v. Ecological studies of the river, and

w. Multiple-purpose project development.

8. COORDINATION

As regional representative of the Chief of Engineers, the Division Engineer of the New England Division, U.S Army Corps of Engineers has been assigned the major responsibility for the accomplishment of the study. Assistance in guidance is afforded by the Coordinating Committee which is comprised of representatives of each of the participating Federal agencies and a representative designated by the Governor of each state within the basin. The Division Engineer as Chairman, will direct the Committee's periodic review of the progress of the study. Committee's functions include the following:

a. Offer guidance,

b. Apprise the heads of the Federal agencies and the States of the trends of the studies,

c. Resolve differences,

d. Assist in coordination of efforts of participants, and

e. Aid in presenting to the public the results of coordinated comprehensive planning effort.

Members of the Coordinating Committee are listed below:

Chairman - *Division Engineer*, U. S. *Army*
Engineer Division, New England.
Col. Remi O. Renier

Membership

States

Massachusetts

Mr. Robert L. Yasi*

Connecticut

Mr. William S. Wise

New Hampshire

Miss Mary Louise Hancock

Vermont

Mr. Richard H. Macomber

Federal

Dept. of Agriculture

Mr. A.C. Addison

Federal Power Commission

Mr. Paul H. Shore*

Dept. of Health, Education, and Welfare

Mr. Frank Tetzlaff*

Dept. of Commerce

Mr. Ralph Kresge

Dept. of the Interior

Mr. Mark Abelson

9. PARTICIPATION OF AGENCIES

Federal agencies are participating in varying degrees with the Corps of Engineers in the study. Their efforts are funded by transfers from the Corps or directly. Several agencies of the States assist in the investigations by providing available data from State studies, and advice to the participating Federal agencies. Contacts between the Federal and State agencies are being facilitated by the Coordinating Committee. The needs and desires of the states in the development of water resources are being ascertained through the Coordinating Committee which also is utilized to consolidate and reconcile participant's views.

A. DEPARTMENT OF THE ARMY

1. Corps of Engineers is to:

a. Coordinate efforts and provide guidance and pertinent data for the investigations undertaken by cooperating agencies as necessary inputs to any specific overall study effort and arrange for and hold conferences and meetings as needed in connection with the study.

b. The Corps will develop through contractural services, a series of projections of those economic indices most indicative of present and future uses of water and related land resources

c. Determine the magnitude of present and future requirements for major flood control measures including local protection and drainage improvements. Evaluate flood problems and measures to lessen these problems in cooperation with the Department of Agriculture.

d. Determine the magnitude of present and future requirements for commercial and recreational navigation facilities and determine measures to satisfy these requirements.

e. Conduct necessary hydrological studies to determine streamflow characteristics, runoff-storage relationships, frequencies of adverse high and low-flow conditions, dependable yields from storage impoundments and optimum streamflow regulation.

f. Inventory, screen, and analyze sites for water resource development in cooperation with other agencies to fulfill the needs for water supply, water-oriented recreation, fish and wildlife conservation, streamflow augmentation, and other purposes.

g. Correlate and consolidate information from studies by participating Federal agencies and from states and provide leadership for the cooperative formulation of a comprehensive framework plan of development of the basin's water resources. The Corps will draft the main report on the investigations and coordinate it at field level with the participating Federal and State agencies.

h. Prepare flood profile data for major areas where community development might be anticipated. Data will reflect the effect of existing and proposed flood control improvements and will be correlated with the probability studies. Subject to the availability of maps of sufficient accuracy, exhibits will be prepared to indicate the extent of flooding for selected probabilities. The profiles and plans of the flood plains will be made available to the local interests for use in achieving an orderly growth of the community and preclude the need for additional costly flood control improvements.

need in upstream watersheds of the basin, including recreation and fish and wildlife development, and, to the extent feasible, the needs of

g. Determine the needed land use adjustments and treatment on open land to assure optimum utilization of the land resources within the capability of the lands.

h. Appraisal of alternative programs for meeting planning objectives.

i. Leadership in preparing a report on the results of the Department's survey.

2. Economic Research Service is to:

a. Compile and analyze statistical material relating to the agricultural economy of the area, cropping patterns, and agricultural output.

b. Appraise future marketing and production technology.

c. Analyze agricultural drought problems with the view of determining net benefits obtainable by drought reduction practices based on an efficient cropping pattern, in keeping with requirements for agricultural products.

d. Analyze agricultural produce needs nationally and regionally and the capability of the available land and water resources to meet these needs.

e. Determine in cooperation with Soil Conservation Service and Forest Service, agricultural and other rural water requirements, both present and projected.

f. In cooperation with Soil Conservation Service, Forest Service, and other agencies, adapt projections of the demand for outdoor recreation and determine the role of agriculture in meeting shortages of outdoor recreation.

g. Making other studies as requested by the Corps of Engineers or other agencies.

h. In cooperation with Soil Conservation Service, Forest Service, and other agencies, appraise the alternative programs for meeting planning objectives with a view toward development of an optimum comprehensive plan as well as participate in the preparation of the Departmental report.

3. Forest Service is to:

a. Inventory, classify, and correlate forest resources of the Basin in terms of present and potential use, physical characteristics, condition, and management levels.

b. Analyze forest resources as related to current and long-range water management needs with regard to erosion control, flood prevention, water supply, and water quality.

c. Inventory and analyze the use of natural resources by forest-based enterprises and related industries and their contribution to the present and prospective economic activity and employment in the Basin.

d. Appraise the relationship of forest resources to agricultural water problems and needs and potential of forest land and water resources for recreational purposes.

e. Estimate probable effects of proposed projects and programs on forest resource yields.

f. Appraise in cooperation with the Soil Conservation Service and Economic Research Service, alternative programs for meeting planning objectives and participation in the preparations of the Departmental report.

g. Analyze use, treatment, development and management * of National Forests to meet basinwide needs for water and related land resource development.

C. DEPARTMENT OF COMMERCE

1. Economic Development Administration. Provide consulting service as to needs in the region and impacts of proposed improvements on redevelopment areas.

2. Bureau of the Census. Furnish population and economic data as available on request.

3. Bureau of Public Roads. Provide consultation as to current and future plans for road improvements or modification in the region and effect of proposed projects on existing and planned highways.

4. Weather Bureau. Furnish meterological data and available studies as requested along with their views as to flood warning measures.

D. FEDERAL POWER COMMISSION is to:

1. Review prior power investigations.

2. Prepare preliminary power values for utilization in screening of projects.

3. Consult with and advise Corps of Engineers relative to potential hydroelectric projects including both conventional projects, pumped-storage projects, and redevelopment of existing facilities.

4. Participate in screening of potential projects including recommendations for investigation of additional sites.

5. Participate in conferences and meetings at Coordinating Committee and working group level throughout the New England region.

6. Prepare estimates of future hydroelectric power demands, setting forth timing and location of anticipated power loads.

7. Analyze value of power to be developed at projects included in alternate plans of development.

8. Prepare power market report for the Connecticut River Basin and adjacent power areas that could be serviced by potential hydroelectric power projects to be developed within the basin, including valuation of this potential power.

E. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE[1/] is to: *

1. Prepare an inventory of existing non-rural water supplies, both municipal and industrial to include the following information:

a. MUNICIPAL WATER USE

1) Existing Water Uses as an Aid to Forecast of Future Water Demands

Type of Use

Significant type of municipal users
Type of use within Municipalities

Distribution

Treatment

2) Fluctuation in Present Water Uses

Under as many of the categories in 1) above as appear applicable, data will be obtained on maximum and minimum present water uses, together with data on daily, weekly, and seasonable fluctuation.

b. INDUSTRIAL WATER USE

1) Existing Water Uses

The types of industrial water usage are to be categorized with respect to:

Type and size of industry

Use of Water

[1/] Work and findings under this section, after being substantially completed, has been transferred to Federal Water Control Administration, Dept. of Interior. Public Health Service, Dept. of H. E. W. is to review final draft of report and provide advice and comment. *

2) Comparison of Connecticut River Basin Industrial Water Uses with National Uses and Uses in Previous Years

2. Prepare estimates of future municipal and industrial water supply demands based on changes in use from a 1960 base and tied to levels for periods identified with dates 1980 and 2020. Municipal and industrial water requirements will be presented as the difference between supported estimates of present requirements and total estimated requirements, with adjustment for relationship of developed supplies and requirements.

The support for estimates of present supply and withdrawal will include data on source of water, surface or ground, and data to support weightings used in conjunction with demographic and economic projections in estimates of future requirements. The estimates shall be made for areas within the basin (similar to, but not necessarily the same as, the sub-basin areas in the Economic Base Survey) and areas outside the basin estimated to require withdrawals from the basin.

The estimated per capita future water demands which, together with estimates of future population (furnished by others), will be used to estimate total future water demands. Per capita usage under many of the categories under 1) will be obtained as an aid in the intervals of future per capita demands. In addition, future demands due to changes in the type of demand will be estimated.

It is probable that industrial expansion and hence water usage in the Connecticut River Basin may be dependent to some extent on the amount and characteristics of the water available. An attempt will be made to estimate future water use based on the continuation of available water.

3. Prepare estimates of changes in water quality of streams, identify those reaches of stream which will benefit from regulation and/or augmentation of flows, and estimate the magnitude of regulation and/or augmentation to effect the estimated changes in water quality. Low flow hydrology studies to be made by the Corps of Engineers will be coordinated with HEW.

a. WATER QUALITY

1) Physical Description of the Connecticut River

Geographic and Hydraulic Characteristics

Flow characteristics

2) Pollution Loads

Sanitary wastes

Industrial wastes

Other wastes

3) Effect of Pollution on Past and Present Water Quality

Physical, chemical, radiological, thermal, and biological characteristics of the stream will be given.

Corelation of streamflow, re-aeration rates, free flow and impoundment conditions, and tidal variations will be evaluated.

4) Pollution Prevention Measures in Effect

Sewage treatment facilities

Industrial waste treatment facilities

Treatment

5) Water Pollution Control Legislation in Effect

Stream classifications

Others

6) Ground Water

Physical, chemical, radiological, and biological characteristics

Pollution significance.

4. Prepare estimates of benefits to be realized from

a. Pollution abatement facilities, including treatment plants, pumping stations, sewer systems, and regulation and/or augmentation of streamflows. The Corps of Engineers will assist in this activity by providing estimates of cost of alternative storage measures as requested by HEW.

b. Provision of storage for municipal and industrial water supplies.

5. Participate in selection of alternative components of basin plans which include elements for water supply or flow regulation storage.

6. Prepare report covering participation in the above items.

F. DEPARTMENT OF THE INTERIOR

1. Bureau of Mines is to:

a. Furnish advice and consultation in the screening of potential development sites and selection of sites for further consideration.

b. Report on the impact of construction of recommended projects on the mineral resources and mineral based industries.

c. Provide data as to current water use by the mining and mineral based industries together with advice as to anticipated changes in the water uses. Will also provide information as to processing changes likely to affect effluents passing into streams.

2. Bureau of Outdoor Recreation is to:

a. Compile an inventory of existing outdoor recreational facilities and furnish estimates of existing and future needs for water related, non-municipal, outdoor recreation. *

b. Evaluate the recreation potential of specific water control structures, both existing and proposed, to determine their importance in any future recreation plan.

c. Evaluate and prepare recommendations for preservation and utilization of scenic, natural, and other water-related recreation resources consistent with other land and water uses.

d. Prepare estimates of cost and evaluations of benefits for recreation development at project sites.

e. Coordinate and incorporate findings and plan of the * *Connecticut River National Recreation Area, authorized by Public Law* 89-616, 89th Congress, S. 3510, approved 3 October 1966.

3. National Park Service is to:

a. Determine effect, if any, of projects proposed under the basin study on archeological, historical, natural, and scientific resources.

b. Evaluate basin's historical and archeological resources to determine sites of national significance and those qualified for registry as National Historic Landmarks, if any.

c. Evaluate basin's natural and scientific resources to identify sites of national significance and national geologic, ecologic, and scenic landmarks, if any.

d. Participate in joint field reconnaissance of important reservoir sites which may be significant enought to warrant National Recreation Area status.

4. Fish and Wildlife Service is to:

a. Furnish estimates of future needs for water related fishing and hunting.

b. Evaluate the fishing and hunting potential of designated water control sites, both existing and proposed, assuming management for resource conservation.

c. Prepare analysis of effects of proposed water development projects on the fish and wildlife resource and recommend conservation and mitigation devices.

d. Prepare summarization of relationship of fish and wildlife resource to comprehensive water resource development plan, and prepare evaluation of benefits and costs associated with the fish and wildlife proposals.

5. Geological Survey is to:

a. Prepare report (describing general geo hydrology of the basin) including plans, depicting areas of potential ground water availability within the basin and those most favorable for development.

b. Make sub-surface investigations of selected areas and report on potential yield and quality of water therein, and will assist in preparing estimates of cost of development.

c. Provide advice as to the effect of plans of development on groundwater reservoirs.

d. Identify areas of current or potential saline water encroachment.

6. Assistant Secretary for Water and Power is to:

a. Determine power marketing criteria and rates for all proposed hydroelectric power projects.

b. Coordinate with Federal Power Commission and Corps of Engineers.

G. STATE LAWS, POLICIES, AND PROGRAMS

The purpose of this outline is to indicate the scope of information desired from participating states and to invite a degree of uniformity in its presentation.

1. State Law

a. Synopsis (brief - principals and concept embodied in State constitution)

1) State Constitution

2) Statutes

3) Case Law

b. Water Rights

c. Regulatory Authority

2. Administrative Structure

a. Interstate

b. State departments and Agencies

c. Boards and Commissions

d. Special-purpose districts

e. Other political sub-divisions

3. Policy

   a. Centralized vs decentralized responsibility for water.

   b. "Home Rule" concept

   c. Financing
   d. Cooperation, coordination, and cost sharing

4. Programs

   a. Research

   b. Data Collection

   c. Planning

   d. Construction and development

   e. Regulation

5. Prosecutions

   a. Policy and program trends

   b. Financing future development

6. Appendices

   a. Inventory - (non-Federal projects) (list by basin)

   b. Bibliography - (list of pertinent state publications)

10. POLICIES AND CRITERIA

a. Maximum utilization is being made of existing data such as the Report of New England-New York Inter-Agency Committee (NENYIAC) and reports of Federal, state, and private agencies. Development of new data is being minimized and screening of alternative measures is being and will be accomplished to the maximum extent practicable by use

of past studies and records, reconnaissance, and consultation among personnel of participating agencies.

b. The investigation will (1) identify the general nature and scope of water resource development needs which will be encountered in future years, confining planning studies to the minimum detail and scope necessary to meet these requirements; (2) define and evaluate in sufficient detail to comprise a basis for authorization of the projects for which Federal authorization will be required to permit necessary construction to be initiated by 1980; (3) identify the nature and scope of the additional elements of the plan which should be undertaken under non-Federal or other Federal programs by 1980; (4) and identify potentials for meeting the needs through 2020 including increased scale warranted at projects required by 1980.

c. Individual study elements are to be considered only to the point necessary to arrive at the conclusions required at the particular stage of the study. Studies of features and elements will be terminated when it is determined that the particular feature or element is not justified for inclusion as part of the comprehensive plan.

d. Active participation and cooperation by Federal agencies and appropriate regional, state, and local public agencies and interests are part of the investigations. The views of each are being considered and taken into account in the determination of requirements and in the formulation of plans for resource use and development.

e. Future needs are being estimated for periods to year 2020. The projective economic study provides the forecast dimension of demographic and economic factors and serves as a tool for estimating requirements for water and related land uses.

f. Consideration is being given for the need for additional water diversion into or out of the basin.

g. The report of the investigations will present in survey scope detail those projects which are to be recommended for Federal implementation.

h. The formulation of plans and evaluation of improvements will conform to policies, standards, and procedures set forth in Senate Document No. 97, 87th Congress, 2d Session, entitled: "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources" and amendments approved jointly by the Secretaries of Agriculture, Army, Interior, and Health, Education, and Welfare.

i. The report will recommend authorization for Federal construction of, or participation in, projects required to meet water resource needs by 1980.

j. The report will present an allocation, on a functional basis, of the costs of recommended projects together with appropriate recommendations, for Federal and non-Federal cost sharing.

k. The report will suggest ways and means to implement the comprehensive plan recommended for initial development and to phase the construction of the elements of the plan.

l. Projects in which there are primary or substantial Federal interests and which are urgently needed may be covered by interim reports. The essentials of such interim reports will be part of the final report.

m. To the extent necessary for plan implementation, the report will present basic principles which should be covered in water resource laws.

n. Public hearings have been or will be held as required to receive information on water resource needs and during later phases of the study to present basin development plans and to receive views relative thereto.

o. Progress reports are being prepared by the New England Division Corps of Engineers in accordance with existing regulations. In addition, periodic reports of status are made to the Coordinating Committee and interested public and private groups are apprised as to status of the investigations.

11. ELEMENTS OF INVESTIGATION

In simplest terms, there are four elements to the investigations leading to a plan of water and related land resource development for a river basin. These elements are (a) the supply of resources, (b) the demand for them, (c) the net demand or needs, and (d) a reconciliation of supply and net demand or needs. In practice, these elements are not investigated one after the other, but rather are investigated simultaneously to the extent possible. The overlapping time relation is displayed on the Sequence Diagram as procedural steps identified as Phases A through E.

a. Supply of Resources.

Because the end purpose of the comprehensive study is to provide a plan for effective water resource development and conservation, there are three aspects of resource supply which must be evaluated. First are the resources themselves, in this case surface and ground water and closely related land resources. Second are the existing developments and programs. Lastly are the potentials for further development or beneficial program implementation. The resources and resources developments and capabilities are being inventoried by various participants. Tentative identification of potentials for water storage and other resources development is being carried on at the same time.

b. Demand for Resources

The demands for resources are not limited to the classical demand of the economist but rather combine this with wants and desires which may be met as objectives of society. Gross demand is measured in such terms as people times per capita requirement such as gallons per day of water per capita (weighting factors) or tons of product times gallons per ton of product required. Projections of gross demand are made using numbers from "Projective Economic Studies of New England" and weighting factors appropriate to anticipated future conditions as developed by separate analysis. The projective studies made especially for this planning and related efforts provide a common framework for use by all participants in expressing demands.

c. Net Demands or Needs for Development

Needs are viewed as those presently unsatisfied demands or those projected to remain unsatisfied in the future without further development or improvement. They are the net of (1) present and future demands generated inside the basin or in outside areas dependent on its resources, and (2) satisfaction by existing developments and programs. Existing resource problems such as flood loss vulnerability and water quality deterioration, and the extension and expansion of these in the future are recognized in the manner of needs. Needs are either expressed in the

same terms as demands or where appropriate in terms of the measures required to satisfy them, as for example, acre feet of storage or miles of channel improvement. Needs topics being considered follow:

(1) Municipal and Industrial Water Supply. Present and future municipal and industrial water quantity and quality requirements to be satisfied from surface and ground water sources are to be estimated. Industrial demands are to include those to be met by municipal systems and those to be met by other means. The quantity and quality of water being returned to streams are to be estimated as a basis for judging receiving stream quality and dilution water requirements.

(2) Agricultural Water Supply. Present and future patterns and intensities of irrigation water application are to be estimated as well as the changing requirements for rural domestic water, stock water, and other agricultural water.

(3) Environmental Improvement. Flow augmentation storage although inherent in resources considerations such as Water Quality, Recreation, Power, Navigation, would be considered separately as a project purpose. The benefits would be derived from the traditional purposes served, as well as from enhancement.

(4) Navigation. Needs for additional commercial and recreational navigation facilities or for flow augmentation to improve navigation within the basin are to be considered.

(5) Electric Power. The future market for electrical power and the feasibility of developing hydroelectric power, including pumped storage, to satisfy a portion of such needs will be investigated. Consideration will also be given to cooling water requirements for thermal generating plants.

(6) Recreation. Recreation needs which could be met by water resources development will be determined and analyzed as a purpose in water resources projects considered for inclusion in the recommended plan of development.

(7) Fish and Wildlife. The fishing and water-related hunting pressures shall be determined as a part of overall outdoor-recreation need and the resource development and management measures to absorb these needs on a continuing basis identified.

(8) Water Quality. Present and future requirements, based on acceptable standards for improving and protecting water quality are to be estimated and the measures necessary to provide water quality control determined. To supplement liquid waste treatment, streamflow augmentation is to be studied as a means of increasing stream capacity to assimilate effluents from treatment plants and polluted runoff from other sources.

(9) Flood Control Requirements. Flood damage data are to be reviewed and modified as necessary to provide bases for identifying damage center and for project formulation and evaluation. Effectiveness of existing and authorized projects is to be reflected in evaluations.

(10) Major Drainage. Future requirements for drainage of lands are to be developed with particular attention to drainage problems requiring establishment of major drainage outlets.

d. Methods of Meeting Needs (Reconciliation)

Given the needs and general potentials for meeting them, it is then the goal of planning to select the types and scales of development of these potentials which can best meet the indicated needs. A number of alternative approaches involving single purpose, and, to a larger extent, multiple purpose solutions are to be explored. From these analyses the more efficient features emerge. These features would be studied in detail using cost-benefit and engineering analyses as the Federal interest in them becomes evident. Basic plan features would be scaled to meet needs projected to develop by 1980. However, where warranted, project scale would be increased to provide satisfaction of needs estimated to develop after 1980.

12. REPORT AND APPENDIX OUTLINE

CONNECTICUT RIVER BASIN

TABLE OF CONTENTS

MAIN REPORT

VOLUME I

II PHYSIOGRAPHY

A. Land - General

1. Surface - Land Forms - Elevation

2. Geology - Soil - Mineral Resources

3. Vegetation

B. Climate - General

1. Precipitation

2. Temperatures - Frost Free Period

3. Evapo-Transpiration

4. Extremes - Storms and Droughts

C. Water - General

1. Runoff

2. Major Streams - Drainage Areas

3. Flow and Fall

a. Flow Irregularities

b. Flow Frequencies

4. Lakes and Ponds, Storage

5. Groundwater

III POPULATION AND ECONOMY

A. Population - General and relation to region

1. Urban - Cities

2. Rural

3. Households

B. Economy - General

1. Employment - establishments

a. Resource

b. Manufacturing

c. Service

2. Income

3. Land Use - Forest, Crop, Pasture, Other

4. Transportation

5. Water Resource Developments

CHAPTER 3 - NEEDS AND PROBLEMS

A. Measurement Tools

1. Projections - Basin and Service Areas

a. Population

b. Economic Indicators

2. Weightings

B. Water Resource Topics

1. Flood Control

2. Water Quality Control

3. Environmental Improvement *

4. Water Supply *

5. Power *

6. Navigation *

7. Outdoor Recreation *

8. Fish and Wildlife *

9. Conservation and Land Management *

10. Other *

CHAPTER 4 - SOLUTIONS CONSIDERED

I CONCEPT OF ANALYSIS

II SINGLE-PURPOSE SOLUTION - BY SINGLE PURPOSE

III MULTIPLE-PURPOSE SOLUTIONS

IV COMPLEMENTARY SOLUTIONS

CHAPTER 5 - ALTERNATIVE PLANS

General

Project Solution

CHAPTER 6 - BENEFITS AND COSTS

Criteria

Benefits

Costs

Allocation of Costs - Purpose

Cost Sharing

Federal

Non-Federal

CHAPTER 7 - CONCLUSIONS AND RECOMMENDATIONS OF INTERESTED PARTIES AND COOPERATING AGENCIES

CHAPTER 8 - THE COORDINATED BASIN PLAN

CHAPTER 9 - VIEWS OF PARTICIPANTS

CHAPTER 10 - RECOMMENDATIONS FOR CONGRESSIONAL ACTION

I APPROVAL OF COORDINATED PLAN

II AUTHORIZATION

A. Construction of Coordinated Plan (Federal) Features

B. Site Acquisition for Federal Projects

CONNECTICUT RIVER BASIN COMPREHENSIVE STUDY

VOLUME II

APPENDIXES

A. HISTORY

Authorizing Resolution

Prior Reports

Brief History

Coordination

Minutes of Coordinating Committee Meetings

B. PROJECTIVE ECONOMIC STUDIES OF NEW ENGLAND (ADL) AND THE CONNECTICUT RIVER BASIN (to include Impact of Tourism)

C. HYDROLOGY

D. WATER SUPPLY AND WATER QUALITY

Federal Water Pollution Control Administration with appropriate review by Public Health Service

E. GROUND WATER

U.S. Geological Survey Report

F. WATER AND RELATED LAND RESOURCE MANAGEMENT AND USE *

U. S. Department of Agriculture Report (includes SCS, ERS, and F. S. Studies)

G. FISH AND WILDLIFE

Bureau of Sport Fisheries and Wildlife Report (includes Bureau of Commercial Fisheries Report)

H. RECREATION

Bureau of Outdoor Recreation Report

I. ELECTRIC POWER

Federal Power Commission Report

J. STATE REPORTS

Volume 1 - Massachusetts

Volume 2 - Connecticut

Volume 3 - New Hampshire

Volume 4 - Vermont

K. *WATER AND LAND RESOURCE PROBLEMS OF THE BASIN AND SUBBASINS*

L. NAVIGATION

M. FLOOD CONTROL

N. OTHER INTERIOR (Bureau of Mines and NPS)

13. WORK SCHEDULES AND COORDINATION OF TASKS.

Work schedules for scope of work outlines delineated in Par. 9, Participation of Agencies, are shown on pages 12-27. The schedule for the various phases of investigations is shown on the sequence diagram on accompanying chart, Exhibit #1. The bars on the diagram identified by agency illustrate two continuing activities -- segments of efforts as inputs of overall study, and preparation of a report on these efforts to be made an appendix to the final report on comprehensive study. It is anticipated that development of Appendices from participants will occur as early as possible and be a continued operation reflecting the availability of data from independent agency activities. Submission of appendix drafts for review is encouraged prior to cut-off shown.

14. SEQUENCE DIAGRAM.

Exhibit 1 portrays in graphic form the sequence of study operations and scheduling of these events. The following changes are to be * incorporated in the Sequence Diagram:

a. As referenced under Bar for APP. F,

(Economic Research Service) - Projective Economics

(Forestry Service) - Forestry

(Soil Conservation Service) - Upstream Water Investigation and Field Survey

b. As referenced under Bar for APP. D, (W.Q.) and (W.S.), * responsibility for this appendix having been substantially completed, prior to establishment of the Federal Water Pollution Control Administration, will be included under the Department of Interior along with Appendixes N., G., H., and E. The Public Health Service, Department of Health, Education, and Welfare will however review final draft of Appendix D and provide advice and comment.

c. APP. N. Add the words "Proj. Eval." during FY 68. *

d. Round-table discussion commenced December 1966. *

ATTACHMENT TO SEQUENCE DIAGRAM

PHASE A DATA ACCUMULATION, DEVELOPMENT, AND ANALYSIS (Mar. 63 - Dec 65)

Schedule

Start	Finish		
Mar 63	Dec 65	1.	Accumulation of existing data on use and supply or resources by office and field study.
Jun 63	Dec 65	2.	Projective Economic Study - population and economic activity guidelines.

PHASE B QUANTIFICATION OF NEEDS AND FIELD RECONNAISSANCE OF SUPPLY (Jul 65 - Jun 67)

Jul 65	Jun 67	1.	Current and future demands minus existing supply equal current and future needs.
Jan 66	Jun 67	2.	Method of rating potential water storage sites established.

PHASE C SCREENING OF POTENTIAL SUPPLY, AND FINAL NEEDS DETERMINATION (Jul 65 - Oct 67)

Jul 65	Sep 67	1.	Analysis of potentials for meeting needs.
Jun 66	Sep 67	2.	Reduction of potentials to most probable alternatives for inclusion in recommended plan of development.
Jul 67	Oct 67	3.	Preliminary economic evaluation of potential measures.

PHASE D PLAN FORMULATION (Jan 67 - Feb 69)

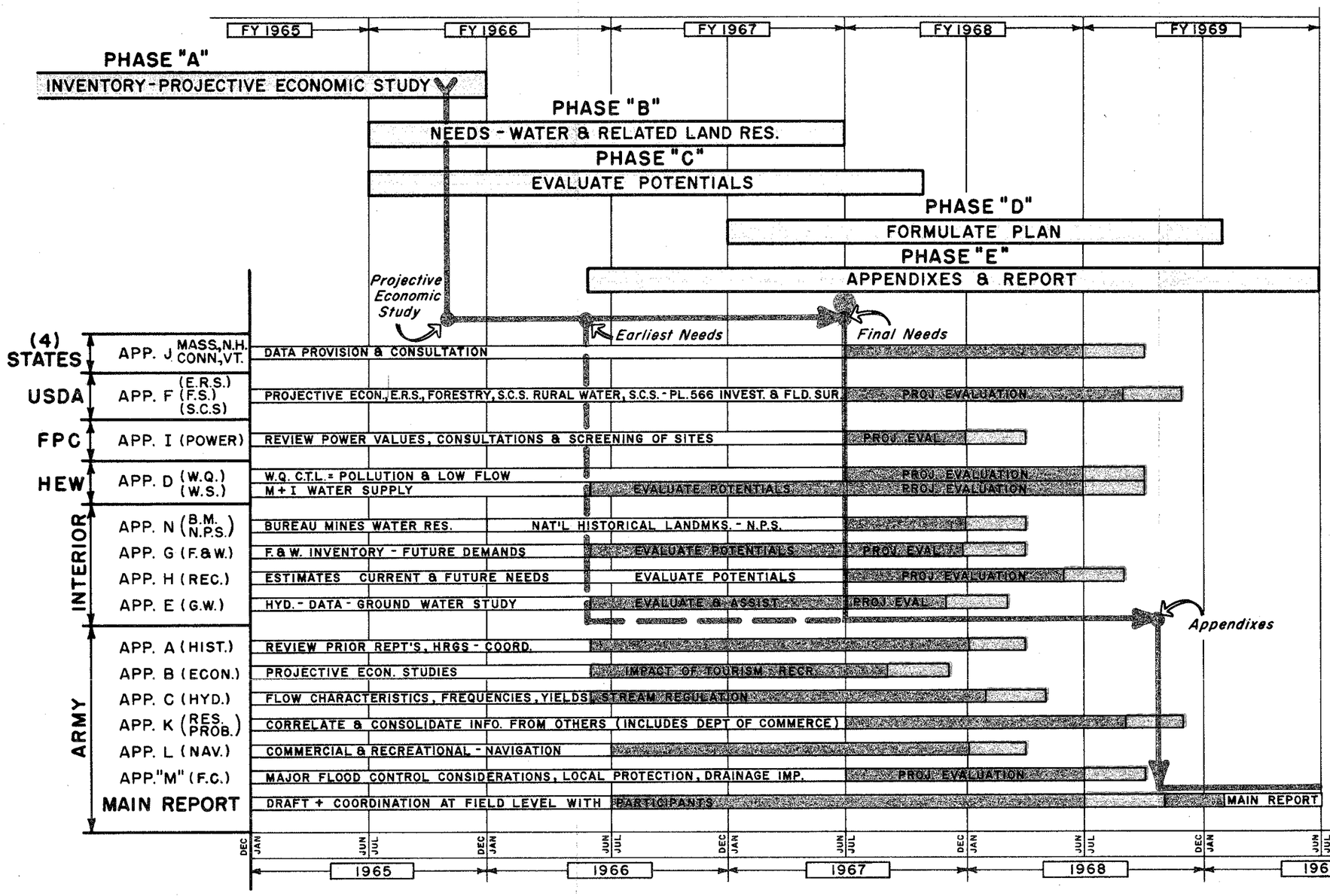
Schedule

Start	Finish		
Jan 67	Jun 68	1.	Detailed analysis of most probable alternatives considering combinations of resource uses or purposes at individual units of plan, and most desirable and feasible scale of development at each unit.
Jun 68	Jan 69	2.	Formulation of alternative basin plans and ultimate selection of plan of development for recommendation.
Nov 68	Feb 69	3.	Economic analysis of alternative plans and recommended plan.

PHASE E REPORTING (May 66 - Jun 69)

May 66	Jun 69	1.	Preparation of report material and appendices material for pertinent resource fields by appropriate departments or agencies with review by all participants.
Oct 68	Feb 69	2.	Draft summary report, review of draft by all participants, and edit final report.
Feb 69	Jun 69	3.	Submission of Report and Appendices.

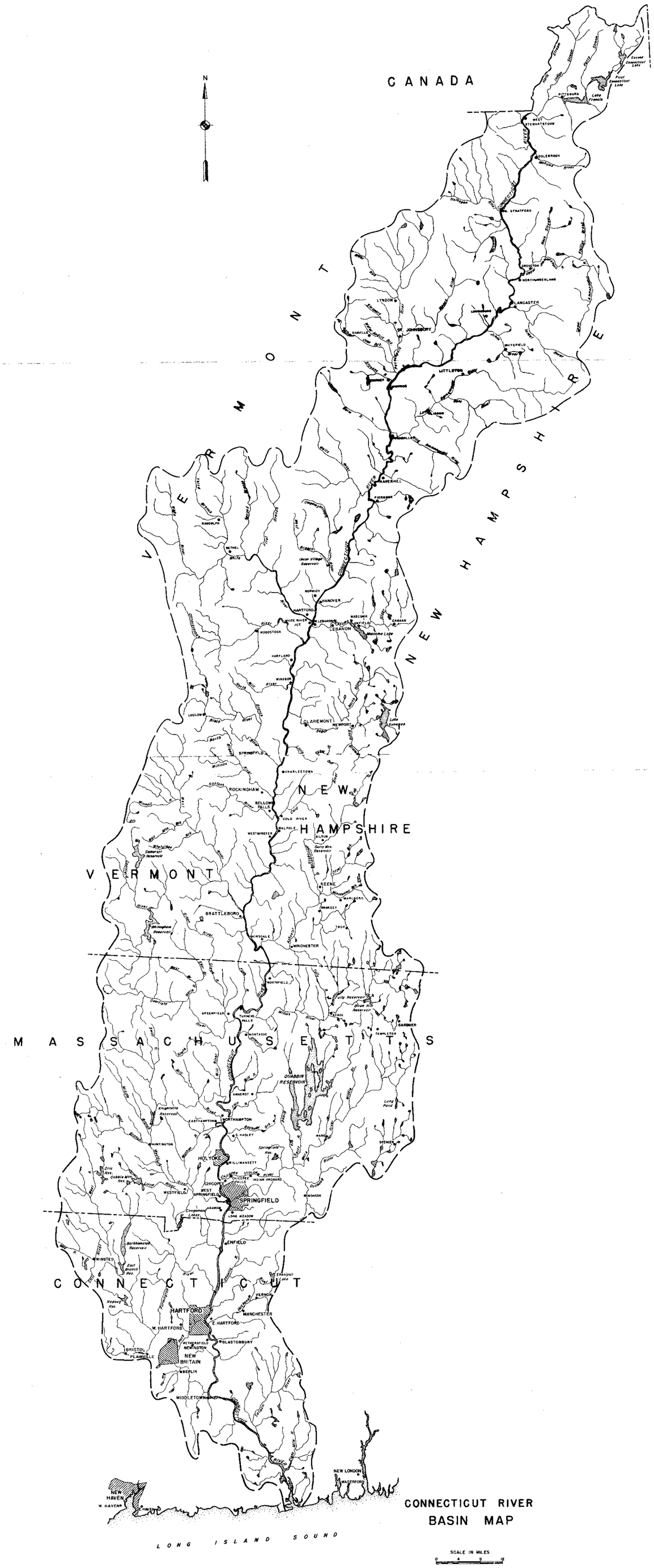
SEQUENCE DIAGRAM - (FY 65 THRU FY 69)
CONNECTICUT RIVER BASIN - COMPREHENSIVE SURVEY



LEGEND

- PRIMARY (CRITICAL) LATEST POSSIBLE TIME
- SECONDARY
- PARTICIPANTS TO SUBMIT OUTLINE OF APPENDIXES
- PHASES A - E
- W.S. = M+I — ACTIVITY BY AGENCY
- APPENDIX PREPARATION
- SUBMIT FOR REVIEW BY PARTICIPANTS

EXHIBIT NO. 1


CANADA
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
LONG ISLAND SOUND
N
Second Connecticut Lake
First Connecticut Lake
Lake Francis
PITTSBURG
WEST STEWARTSTOWN
COLEBROOK
STRATFORD
NORTHUMBERLAND
LANCASTER
LYNDON
ST. JOHNSBURY
DANVILLE
WHITEFIELD
LITTLETON
WOODSVILLE
PLYMOUTH
HANOVER
NORWICH
HARTFORD
WHITE RIVER JCT.
LEBANON
WOODSTOCK
HARTLAND
WINDSOR
LUDLOW
CLAREMONT
NEWPORT
SPRINGFIELD
CHARLESTOWN
ROCKINGHAM
BELLOWS FALLS
WESTMINSTER
WALPOLE
KEENE
BRATTLEBORO
WINCHESTER
NORTHFIELD
GREENFIELD
TURNERS FALLS
MONTAGUE
AMHERST
NORTHAMPTON
HOLYOKE
WILLIMANSETT
WESTFIELD
WEST SPRINGFIELD
SPRINGFIELD
ENFIELD
WINSTED
VERNON
MANCHESTER
E. HARTFORD
W. HARTFORD
GLASTONBURY
BRISTOL
PLAINVILLE
NEW BRITAIN
BERLIN
MIDDLETOWN
NEW LONDON
WATERFORD
NEW HAVEN
W. HAVEN
CONNECTICUT RIVER
BASIN MAP
SCALE IN MILES
0 4 8 12